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ORIGINAL ARTICLE

# Back posture education in elementary schoolchildren: a 2-year follow-up study

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**Abstract** Within the scope of primary prevention regarding back functioning in children, research on the stability of intervention effects is indispensable. Along this line, the transition from childhood to adolescence is an important phase to evaluate the potential stability of intervention effects because of the typically mechanical and psychological demands related to adolescence. The main aim of the current study was to investigate the effects of a back education program at 2-year follow-up, in youngsters aged 13–14 years, on back posture knowledge, fear-avoidance beliefs and self-reported pain. An additional purpose was to evaluate which aspects of postural behavior were integrated in youngsters' lifestyles. At 2-year follow-up, the study sample included 94 secondary schoolchildren in the intervention group (mean age 13.3 ± 0.8 years) and 101 controls (mean age 13.2 ± 0.7 years). The back posture program that had been implemented for two school years consisted of back education and the stimulation of postural dynamism in the class through support and environmental changes. A questionnaire was completed comparable to the pretest, posttest and follow-up evaluations. The current study demonstrated at 2-year follow-up stability of the improved general ($F = 1.590$, ns) and specific ($F = 0.049$, ns) back posture knowledge in children who had received early back posture education. Back posture education did not result in increased fear-avoidance beliefs ($F = 1.163$, ns) or mounting back and/or neck pain reports ($F = 0.001$, ns). Based on self-reports for postural behavior, youngsters who had received the back posture program in the elementary school curriculum integrated crucial sitting and lifting principles conform to biomechanical favorable postural behavior. The steady intervention effects 2-year post-intervention demonstrated that intensive back posture education through the elementary school curriculum is effective till adolescence. Future research on the impact of early school-based back posture promotion in relation to the integration of back posture principles according to a biomechanical favorable lifestyle and back pain prevalence later in life is essential.

**Keywords** Back education program · Prevention · Schoolchildren · Follow-up

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## Introduction

In children and adolescents, epidemiological evidence indicated lifetime prevalence for back pain varying from 13 to 51% and point prevalence ranging from 1 to 31% [15, 16]. For the majority of the children, back pain experiences are non-specific and mild in nature [17] not leading to functional restrictions in their daily life [16, 28]. However, epidemiological research established a range of 7–27% children with recurrent low back pain [15]. Children with recurrent or continuous back pain reported a reduced quality of life and were found to use more medical attention and to consume more analgesics [15]. Besides, the findings of tracking studies consistently pointed out that back pain reports in childhood and early adolescence are significantly related to back pain reports in adulthood [2, 11,

15]. Therefore, several authors recommended research into the early stages of the problem in order to determine the possible key role of early prevention efforts [6, 30].

Not withstanding, the multi-factorial risk for developing back pain in childhood [17] complicates the determination of predisposing factors and preventive measures. In order to provide evidence on early prevention in low back pain, the determination of modifiable risk factors and the results of school-based intervention studies are essential [5].

However, the findings of multiple studies on modifiable risk factors for back pain at young age considering personal characteristics, lifestyle correlates and functional aspects presented conflicting results [5]. Further, the limited literature has indicated that the school environment exposes children to the possible loading factors with respect to prolonged poor sitting [18, 23] and absence of appropriate furniture [19, 22, 24, 25]. Therefore, the school system represents an ideal setting for back pain prevention since it has the potential of optimizing environmental conditions in relation to spinal loading and giving prolonged feedback with regard to good body mechanics. Another advantage of prevention through the school setting includes that nearly all children can be reached.

The promising findings of school-based interventions with respect to good body mechanics in schoolchildren supported the implementation of back posture programs in the school curriculum. However, Cardon and Balagué [5] reported methodological restrictions of intervention studies regarding limited participants, non-randomized study designs and short implementation times. The European guidelines regarding the prevention of back pain, which were formulated at request of the European Commission, stipulated the need for school-based intervention studies and confirmed the methodological shortcomings of intervention studies [10]. Furthermore Steele et al. [29] recently evaluated the quality of school-based interventions and correspondingly concluded that the majority of intervention studies was limited owing to methodological restrictions with regard to intervention aspects or study characteristics.

Therefore, a comprehensive intervention study was designed excluding limitations with regard to a short implementation time, a unimodal approach, small study sizes and a non-randomized controlled sample. In a previous study [13] the intervention effects of the latter 2-school-year multi-factorial back education program on school-related correlates were investigated in 9- to 12-year-old schoolchildren. The study findings indicated that the intervention resulted in increased back posture knowledge, improved postural behavior during material handling and while sitting during lesson time. Additionally, the intervention did not result in increased fear avoidance beliefs or augmented back pain prevalence, which may be a negative consequence of attention for back-related topics [3, 4].

Within the scope of primary prevention regarding back functioning in children, research on the stability of intervention effects is indispensable [5, 29]. Along this line, the stability of intervention effects was shown in our 1-year follow-up study [12]. According to the study-design, the study sample at 1-year follow up included a mixed population of elementary (12 years of age) and secondary (13 years of age) schoolchildren. Since the intervention comprised back posture education in addition to the stimulation of postural dynamism through environmental influence and support by the class teacher, the possible influence of continued environmental support through the elementary school setting needed to be considered during the first year post-intervention. Conversely, 2 years after intervention completion, all children attended secondary schools (13–14 years of age) implying considerable differences when compared to the elementary school outline. In the first place, the secondary school is known for significant homework after school time in comparison to the elementary school. In the second place, at 13–14 years of age the transition from childhood to adolescence takes place, which is characterized by a biological impact (maturation) and psychosocial implications (psychological development, switch in educational system, exposure to plenty of new interests and influences throughout the peer group). During this transition period, stooping postures are frequently adopted for whatever reason (feelings of shame for the changing body or imitations in conscious of being ''cool''), which may result in pressure on the anterior aspects of the vertebral growth plates [32]. As a final aspect, the mounting back pain reporting around the growth spurt [1] justifies research on the stability of early intervention effects in youngsters at secondary school age.

Accordingly, the main aim of the current study was to investigate the effects of a back posture education program at 2-year follow-up on back posture knowledge, fear-avoidance beliefs and self-reported pain. Since the 2-year intervention to promote good body mechanics by increasing postural dynamism attempted to introduce biomechanical favorable back posture principles in children's daily lifestyle, an additional purpose was to evaluate which aspects of postural behavior were intensively integrated in their lifestyle.

## Materials and methods

### Subjects

Eight Flemish elementary schools were selected by simple randomization. Flanders is the Dutch speaking part of Belgium. Children were randomized at school-level into the intervention and the control group (ten intervention class groups out of four schools, ten control class groups out of four schools). All schools were comparable with regard to geographic location and parental education levels.

The multi-factorial back education program started in November 2002 after pre-testing in September and October 2002. Post-testing was performed from April until June 2004. The first follow-up evaluation was organized in April until June 2005. The current follow-up evaluation was organized in March 2006, 2 years after the program was finished.

At baseline, the study sample consisted of 398 schoolchildren who started fourth and fifth grade of elementary school (ages 9–11). At 2-year follow-up, the intervention group consisted of 94 secondary schoolchildren in the seventh or eigth grade (43 boys, 51 girls; mean age at 2-year follow-up 13.3 ± 0.8 years) and the control group included 101 children in secondary schools (45 boys, 56 girls; mean age at 2-year follow-up 13.2 ± 0.7 years). The response rate in relation to the composition of the study sample over the 4 years is presented in Fig. 1.

### Evaluation instruments

Children completed a questionnaire with regard to back posture knowledge and back function, which demonstrated good test–retest reproducibility [8]. Specific back posture knowledge was evaluated through ten questions directly corresponding to the content of the back education program. A multiple-choice quiz including 11 items evaluated general back posture knowledge. Fear-avoidance beliefs were evaluated through five questions on a 5-point-scale with a low score representing low fear-avoidance. Finally, the questionnaire included questions related to back and neck pain prevalence within the last week.

At 1- and 2-year follow-up, the questionnaire integrated an additional part for children of the intervention group asking in which degree they could remember the back education sessions (4-point-scale from nothing to everything) and how frequently they used the back posture principles in their current daily live (5-point-scale from never to ever).

At 2-year follow-up, 20 supplemental questions on children's postural behavior were included. Therefore, the use of back posture principles during daily live was evaluated through ten questions (see Table 3). In addition, postural behavior in the class during lesson time (two questions) and during studying at home (three questions) was questioned. Furthermore, postural aspects with regard to spinal loading during regularly sitting on a chair (three questions) and the use of ergonomically designed material in the class (one question) and at home (one question) were asked. All supplemental questions were rated on a 5-point-scale (from never, to ever) and addressed to both the intervention and the control group.

### Procedure

The questionnaire used at 2-year follow-up was for the major part identical to the preceding evaluations. At pre- and post-test, the questionnaires were filled out at

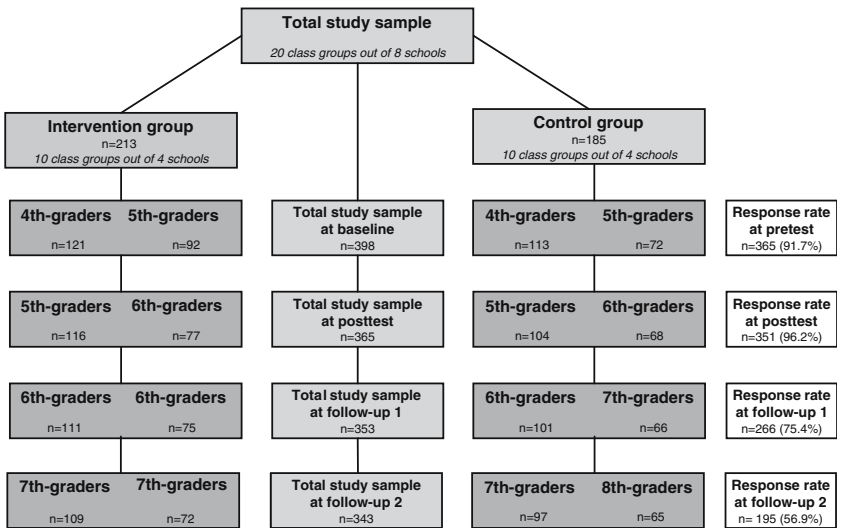


**Fig. 1.** Flow of study sample and response rate

school under supervision of the class teacher. At 2-year follow-up, all children were reached by mail to complete the questionnaires independently at home. Children were asked to fill out their names on the surveys. To minimize socially desirable answers, they were clearly informed about the anonymous data processing. They were invited to return the questionnaire in a presented stamped and addressed envelope. One month after mailing the questionnaires, the non-responders were contacted once by a personal phone call in order to stimulate them to complete and return the questionnaires. The study protocol was approved by the Ethical Committee of the University Hospital of the Ghent University.

### Intervention

The intervention to promote good body mechanics in elementary schoolchildren was a multi-factorial back posture program with involvement of the class teacher during two school-years, as described in a previous study [13]. The basic program consisted of six back education lessons at 1-week interval, taught by a physical therapist to one class group at a time. Pupils were taught anatomy and pathology of the back in the context of optimal loading of the body structures. Furthermore, the basic principles of biomechanical favorable postures were taught and practiced. In addition to the back education sessions, didactic material was provided for the class teachers and guidelines were presented in order to optimize integration of the learned back posture principles. Furthermore, the multi-factorial intervention incorporated an extra focus on postural dynamism in the class by stimulation of dynamical sitting and prevention of prolonged static sitting. Active and variable sitting were reinforced by providing two pezzi balls, a dynair and a wedge in each classroom. Further, short movement breaks were introduced between the lessons. Additionally class teachers were encouraged to teach following an activating approach (e.g., distribution of handouts systematically through children, use of sitting alternatives, variable work organizations like standing work places) and to change structural aspects in the class organization (e.g., decentralized storing places for educational tools, textbooks and schoolbags).

### Data analysis

Data analysis was performed using SPSS 12.0. The level of significance was set at 5%. A dropout analysis was executed using Independent Samples *t* tests in order to determine baseline group differences between non-responders versus responders. The stability of the intervention effects after a 2-year follow-up interval was explored using Repeated Measures Ancova, with baseline scores as covariates. Time was included as within-subjects factor (post vs. 2-year follow-up evaluation) and condition as between-subjects factor (intervention vs. control group). Gender was included as a second between-subjects factor in order to evaluate three-way-interaction effects. Intention to treat analyses were performed but provided identical results (non-significant interaction effects for all variables, $F < 2.260$, ns and mixed main effect of condition: general back posture knowledge, $F = 48.840$, $P < 0.001$; specific back posture knowledge, $F = 23.386$, $P < 0.001$; fear-avoidance beliefs, $F = 0.051$, $P$ ns; back pain reporting $F = 0.379$, $P$ ns). Therefore, the results were only reported for the responding children out of study sample at 2-year follow-up. Finally, the 2-year follow-up data on children's self-reported postural behavior during school time and daily activities were analyzed performing Pearson Chi-Square techniques after re-coding the variables (the scores 1–3 on the 5-pointscale ranging between never and ever were recoded into 0 and represented ''unusual postural behavior'' while the scores 4–5 were recoded into 1 representing ''usual postural behavior'').

## Results

### Dropout analyses

A comparison between responders and non-responders within the pre- and post-2-year-follow-up design is presented in Table 1. Children who answered the questionnaires at 2-year follow-up had a higher general back posture knowledge score at baseline ($P < 0.05$) and were 0.2 years younger ($P < 0.05$) in comparison to the non-responders.

### Stability of intervention effects

#### *Postural knowledge, fear-avoidance beliefs and self-reported pain*

Table 2 and Figs. 2, 3, 4, and 5 present the changes in general and specific back posture knowledge, fear-avoidance beliefs and self-reported pain comparing the intervention group versus the controls between post-test and 2-year follow-up evaluation. For none of the variables interaction effects were found revealing stable

**Table 1** Group differences between responders and non-responders within the pre- and post-2-year follow-up design (Independent samples *t* test)

| At baseline variable (theoretical range) | Mean total score (range) | | Group difference | |
|---|---|---|---|---|
| | Responders ($n$ = 195) | Non-responders ($n$ = 203) | $t$ value | $df$ |
| General back posture knowledge (–1 to 11) | 1.4 (–2 to 11) | 0.3 (–2 to 10) | 2.899* | 362 |
| Specific back posture knowledge (–10 to 10) | 5.1 (–7 to 10) | 4.8 (–11 to 9) | 1.461 | 362 |
| Fear-avoidance beliefs (5–25) | 16.9 (5–25) | 17.0 (5–25) | 0.271 | 362 |
| Self-reported back and/or neck pain (%) | 32 | 30 | 0.430 | 363 |
| Gender (girls%) | 55 | 48 | 1.361 | 396 |
| Age (years) | 9.8 (8.1–12.5) | 10 (8.7–12.5) | 2.492* | 359 |

**$P < 0.001$, *$P < 0.05$

**Table 2** Back posture knowledge, fear-avoidance beliefs and back and/or neck pain prevalence in the intervention and the control groups at post-test and at 2-year follow-up (repeated measures ancova)

| Variable (theoretical range) | Mean total score (*SD*) and prevalence | | | | Effect | |
|---|---|---|---|---|---|---|
| | Post | | 2-year follow-up | | T × C | C |
| | I | C | I | C | $F_{(df = 1)}$ | $F_{(df = 1)}$ |
| General back posture knowledge (–11 to 11) | 5.4 (2.8) | 3.1 (3.0) | 5.9 (2.8) | 4.2 (2.7) | 1.590 | 31.482** |
| Specific back posture knowledge (–10 to 10) | 7.7 (2.1) | 6.7 (2.3) | 8.6 (1.4) | 7.6 (2.0) | 0.049 | 20.750** |
| Fear-avoidance beliefs (5–25) | 16.3 (4.7) | 17.2 (3.9) | 15.2 (3.8) | 15.4 (3.3) | 1.163 | 1.293 |
| Self-reported back and/or neck pain (%) | 29 | 32 | 20 | 23 | 0.001 | 0.522 |

**$P < 0.001$, *$P < 0.05$

*SD* standard deviation, *I* intervention group ($n$ = 86), *C* control group ($n$ = 99), $T \times C$ time × condition (interaction effect), *C* condition (main effect of group)

effects when comparing the intervention group to the controls between post-test and 2-year follow-up. For general and specific back posture knowledge the main effect of condition was significant, revealing better knowledge scores in the intervention group compared to the controls both at post-test and at follow-up. No main effect of condition was found for fear-avoidance beliefs and self-reported pain. The three-way interaction including gender showed no significance for specific back posture knowledge ($F = 0.916$, ns), fear-avoidance beliefs ($F = 0.484$, ns) or self-reported pain ($F = 0.406$, ns), which means that the specific knowledge scores, fear-avoidance beliefs and back pain-reports changed similarly in boys and girls. The three-way interaction on general back posture knowledge was significant ($F = 2.242$, $P < 0.05$). Further analyses showed that the scores on general back posture knowledge were stable in boys of the intervention group compared to improved back posture knowledge in boys of the control group ($F = 4.017$, $P < 0.05$). In girls of the intervention the scores on general back posture knowledge did not differ significantly between post-test and follow-up in comparison to the controls which means that the change over time was similar in girls of both conditions.

### *Children's perceptions about the promotion of good body mechanics*

Two years after program completion, 96% of the children remembered the back posture education sessions. The major part (70%) reported that they remembered ''much'' to ''everything'' of the back education sessions, 29% remembered only a ''little'' and one child reported to remember ''nothing''. Additionally, a large part reported to use the back posture principles ''almost always to always'' (55%) and ''sometimes'' (35%), while only 9% of the children used the learned back posture principles ''now and then'' and two children (1%) reported to use the principles ''never'' in daily live.

### Postural behavior at 2-year follow-up (post-intervention evaluation)

Table 3 presents group differences at 2-year follow-up in personalized aspects of postural behavior conform a biomechanical favorable lifestyle between children who had received back posture education and controls. Significant differences were found for three of the ten back posture principles, which were all aspects

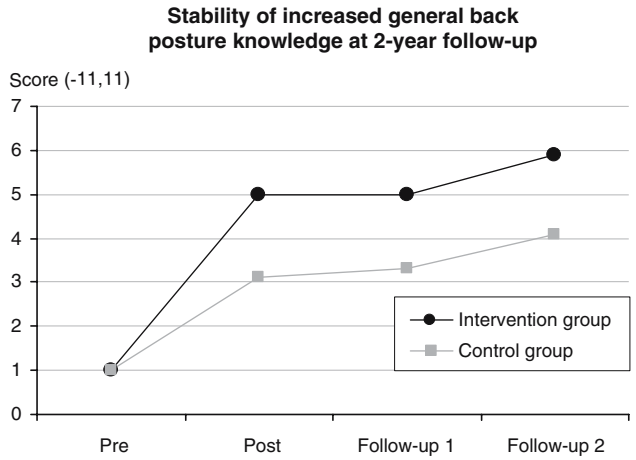


**Fig. 2** Change of general back posture knowledge over 4 years

conform good lifting technique. Evaluation of the reports on other back posture principles showed no differences between both groups. Further, the major part of the children reported that carrying a book bag on the back, carrying an object as close as possible to the body and joining sport activities three times a week were common habits (>60% of all children). On the other hand, a limited percentage of children (<30% of all children) reported to pay attention for the neutral spinal curvature, to relax with lifted legs, to check the weight of their school bags and to place homework on an inclined surface. Furthermore, a significant larger proportion of children in the intervention group reported that they pay attention to their posture while sitting during class activities compared to the controls (31 vs. 14%). Accordingly, there was a trend towards significance for a larger part of the intervention children reporting to pay attention to their posture while sitting during study time (19 vs. 10%). The low percentages showed that these aspects were only generalized in the lifestyle of a limited number of children. Finally, significantly more intervention children reported that they had included postural aspects preventing spinal loading during sitting activities when compared to the control group (back rest use 68 vs. 50%, arm support 59 vs. 41%, feet on the floor 68 vs. 45%). Further, children reported that ergonomic materials were not applicable in their secondary schools. Finally, between intervention children and controls no differences were found with regard the use of ergonomic materials at home.

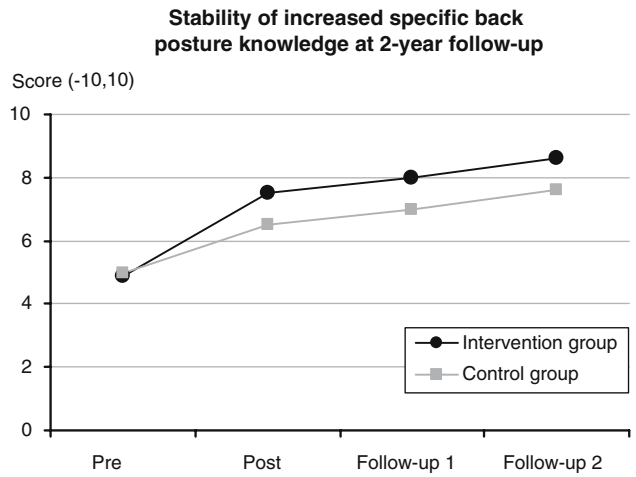


**Fig. 3** Change of specific back posture knowledge over 4 years

## Discussion

The main aim of the current study was to investigate 2-year follow-up effects of early back posture education through the elementary school curriculum. Additionally, self-reported postural behavior in youngsters' daily activities was investigated in relation to a biomechanical favorable postural lifestyle (removed sentence).

Based on our previous study [13], immediate intervention effects of multi-factorial school-based back posture program included improved general and specific back posture knowledge. The current study demonstrated for the 2 years following after completion of the back posture program an increase of back posture knowledge in both conditions, but at a higher level for the children who had received the back posture program. The latter picture may support the presumption that children's knowledge expands with age. Further, it seemed that improved back posture knowledge after back posture education may persistently assure greater back posture related knowledge. A right conception of biomechanical favorable postural behavior is a necessary condition for the development of a conscious and lifetime healthy lifestyle with respect to good body mechanics [21]. However, good back posture knowledge is not the only aspect promising adequate postural behavior in relation to a biomechanical favorable lifestyle [9].

Two years after completion of the back posture program, more intervention children reported that they had integrated biomechanical favorable back posture principles into their daily lifestyles with regard to lifting (bending knees, standing close to object, asking for help) and sitting (back rest use, arm support, feet to the ground) when compared to the reporting of the controls. These study findings may be important since a review on risk factors related to back pain at young age indicated that sitting is the most common

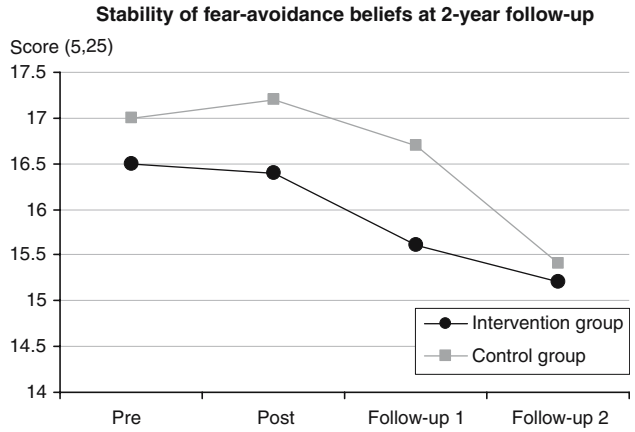


**Fig. 4** Change of fear-avoidance beliefs over 4 years

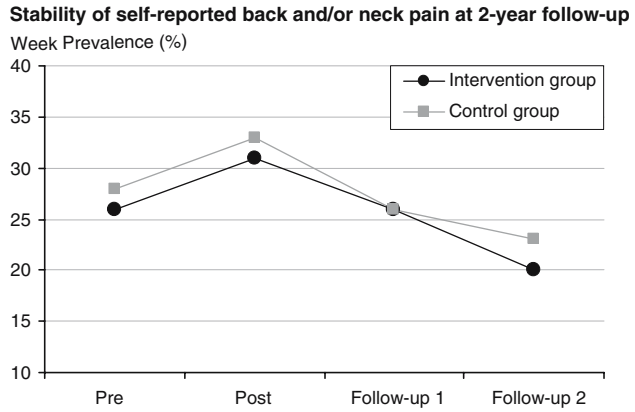


**Fig. 5** Change of back pain reporting over 4 years

factor associated with back pain reports in youngsters [1]. Furthermore, at adolescent age youngsters typically adopt stooping postures, which may result in pressure on the anterior aspects of the vertebral growth plates [32]. In addition, the present findings at 2-year follow-up on lifting aspects, which suggest the implementation of principles in relation to a biomechanical favorable lifestyle, are positive owing to the impact of lifting activities that may increase in youngster's daily life at secondary school age (such as in vocational education). On the other hand, the reports of the youngsters on postural aspects in the class and during study time did not differ between the intervention and the control groups with the exception that youngsters who had received back posture education reported regularly paying attention to their posture during class activities (31 vs. 14%). Based on the reports of the youngsters, the more specific aspects promoting optimal daily load on the spinal structures such as lifting the legs when relaxing and working on an inclined surface did not seem to be integrated into their daily lifestyles. Concluding the reporting on postural behavior, one can assume that youngsters who received back posture education may have relieved some daily loading factors by integrating biomechanical favorable postural principles. An interesting research question is whether these principles will be used later in the occupational setting and whether this has an impact on adult back pain with regard to work-related consequences.

Besides the wide range of arguments to justify back posture education at young age, Burton [4] warned for the potential of increased fear-avoidance beliefs as a consequence of early back education. Based on the literature, high fear-avoidance beliefs and misconceptions about pain are persistent in adults playing a significant part in the development of long-term disability [14]. Given the lifetime prevalence for back pain in adulthood, 80% of the children will experience back pain at some point in life [31]. Therefore, it is important that children who received early back education have no increased fear-avoidance beliefs. The present 2-year follow-up study indicated that the back posture program did not result in increased fear-avoidance beliefs between post-test and 2-year follow-up evaluation and over the 4-year time span.

The present back posture program in the elementary school did not result in decreased back pain reporting. The lack of evidence for the direct impact of primary prevention on back pain prevalence [20] is a critical point in the prevention discourse, certainly in children [5]. The general nature of common back pain experiences implies a limited scope for preventing back pain incidence. Therefore, early interventions might better focus on the possible change of correlates influencing spinal loading in the school environment in relation to the possible change of back pain prevalence in the longer term. However, the evaluation of short-term effects on back pain reporting is ambitious because of the double knife-edge. Even though the intervention did not lead to reduced back pain reporting in children, the early back posture education did not result in increased back pain reporting two year after intervention completion, which may be a negative result of the attention for back topics. Overall, the current prevalence rates for back and neck pain varying from 20 to 32% over the 4-year time span are in line with the prevalence reports in the literature [7, 27]. The lack of effect on pain reporting at young age may be due to the mild nature of pain and the fact that children's pain reports are mainly associated with psycho-social factors.

Judging the limitations of the present study, the use of self-reported postural behavior needs a critical approach. Although the children were informed about

**Table 3** Comparison of the number of children with personalized good back posture principles between the intervention group and the controls at 2-year follow-up (Chi-Squared Test)

| Questions about postural behavior | Children with good postural behavior | | Group difference |
|---|---|---|---|
| | I (%) | C (%) | $\chi^2$ $_{(df = 1)}$ |
| Back posture principles | | | |
| Do you pay attention to the natural curvature of your spine? | 20 | 16 | 0.637 |
| Do you join sport activities three times a week (e.g., swimming, jogging)? | 67 | 63 | 0.344 |
| When you relax, do you lie down on your back with your legs lifted? | 26 | 26 | 0.013 |
| When you bend, do you bend your knees and not your back? | 71 | 54 | 6.162** |
| When you lift, do you stand as close as possible to the object? | 78 | 59 | 7.530** |
| Do you ask for help to lift a heavy object? | 68 | 55 | 3.708* |
| Do you carry an object as close as possible to your body? | 77 | 66 | 2.649 |
| Do you carry your book bag on your back? | 96 | 93 | 0.712 |
| Do you check the weight of your book bag? | 17 | 11 | 1.394 |
| Do you place your book/homework on an inclined working table/ring binder? | 17 | 17 | 0.038 |
| Postural behavior in the class | | | |
| When you sit in the classroom, do you pay attention to your posture? | 31 | 14 | 7.741* |
| When you sit in the classroom, do you change your posture? | 60 | 61 | 0.053 |
| Postural behavior during study time | | | |
| When you make your homework, do you pay attention to your posture? | 19 | 10 | 3.284*** |
| When you make your homework, do you change your posture? | 53 | 42 | 2.026 |
| When you make your homework, do you interrupt your sitting activity? | 48 | 38 | 1.999 |
| Loading factors related to sitting | | | |
| When you sit on a chair with a backrest, do you use the backrest? | 68 | 50 | 6.833* |
| When you sit, do you make that your arms are supported? | 59 | 41 | 6.277* |
| When you sit, do you sustain your both feet to the ground? | 68 | 45 | 10.868** |
| Use of ergonomic material | | | |
| Do you use ergonomic material in the classroom (like a sitting ball or wedge)? | – | – | NA |
| Do you use ergonomic material at home (like a sitting ball or wedge)? | 6 | 11 | 1.394 |

*I* intervention group ($n = 86$), *C* control group ($n = 99$), *NA* not applicable, $\chi^2$ Pearson Chi-Square

*$P < 0.05$, **$P < 0.001$, ***$P < 0.09$

the anonymous data processing, children who have received the back posture program may have reported social desirable answers (conform to good body mechanics), which may have resulted in an over-reporting of good postural behavior. However, in the current study the percentages showed realistic figures in addition to variability between the different questions (not ''every'' aspect was ''simply'' integrated), which may suggest adequate reporting of postural behavior. Nevertheless, the objective measurement of youngsters' postural behavior in order to evaluate the longer term practice of different postural aspects with regard to daily sitting and lifting after back posture education at early age, may embrace a suggestion for future research.

The 50% dropout after the four evaluations and the reality that those who were lost at follow-up were slightly older at baseline having less general back posture knowledge in comparison to the responders at 2-year follow-up included a second limitation. Therefore, the findings of the current study need careful interpretation with regard to generalization. However, the dropout rate of the present study was comparable to the 38% dropout in the 1-year prospective study by Feldman et al. [11]. Furthermore, the present total study sample still consisted of 195 subjects. This sample size is relatively large compared to the study samples of other intervention [29] or prospective [26] studies and may suggest some general relevance.

Considering a last limitation, the possible influence of confounding factors unrelated to the back posture intervention was carefully controlled during the 2-year interval of back posture education in elementary schoolchildren [13]. In the present evaluation at secondary school age, possible interfering factors related to the intervention program were not controlled. Pragmatically, there is a chance that secondary schools provide back posture topics since in Flanders school policies may autonomously decide to include heath related topics within the mandatory curriculum. However, the fact that the participants of both conditions attended multiple secondary schools makes the possible influence of interfering factors similar in both conditions. The black box condition during the follow-up period may even strengthen the current findings on the stable intervention effects of early back posture education.

## Conclusion

The steady intervention effects 2-year post-intervention demonstrated that the intensive implementation of the present multi-factorial back education program in the elementary school curriculum improved children's back posture knowledge. Additionally, the back posture program did not result in increased fear-avoidance beliefs or mounting back and/or neck pain reports over the 4-year time span. Finally, based on self-reports for postural behavior the present study results indicated that youngsters who had received back posture education in the elementary school curriculum integrated crucial sitting and lifting principles significantly more conform to biomechanical favorable postural behavior. However, it is unknown if these intervention effects are also biologically significant. While medicalising back pain in schoolchildren needs to be avoided, future research on the impact of early school-based back posture programs in relation to the integration of back posture principles according to a biomechanical favorable lifestyle and back pain reporting later in life is of interest.

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